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THE NITROGEN CYCLE IN THE COURSE OF STUDY RELATED TO THE BIOLOGICAL SCIENCES AT VARIOUS LEVELS

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ABSTRACT

All living (Plants and Animals) maintain interdependency among them among them in the environment plants waste products are useful for animals and animal waste products are useful for plants. Nitrogen is essential nutrients for all cells. Nitrogen is released in the waste products animals, and it is consumed by plants as their food materials. The nitrogen cycle is the component of biogeochemical cycle. Biogeochemical cycle shows the interdependency among plants, animals and natured environment. This is also essential knowledge for everybody studying the biology at various levels

KEYWORDS: Nitrogen cycle, components, Assimilation, fixation and Regulation.

INTRODUCTION:

Biology is the science of study of all living things & it may be known as life science. With the studies of animals and plants, it is must to know about the environment and gases of environment which are also effective sources for animal's and plant's lives. It is commonly known as there are two gases of environment, oxygen and carbon dioxide which affect the animals and plant's lives. During respiration the animals and plants both take oxygen and release the Carbon dioxide, but in the process of photosynthesis the plants only take the carbon dioxide and release the oxygen. Plants take the oxygen during night and release the carbon dioxide. During the process of photosynthesis plants take the Carbon dioxide and release the oxygen during the day times. Besides, these two gases, some more gases also affect the animal's and plan's plant's lives, the nitrogen is also one of them. Nitrogen is an essential nutrient for all cells. Nitrogen acquisition by biological systems is accompanied on its reduction to ammonium ion (NH_4^+) and the incorporation of NH_4^+ t into organic linkage ass amino or amido groups. The reduction of No_3- to NH_4^+ occurs in green plants, various fungi, and certain bacteria in a two-step metabolic pathway known as nitrate assimilation. The formation of NH_4^+ from nitrogen gas (N_2) is termed nitrogen fixation. Nitrogen fixation is an exclusively prokaryotic process; although bacteria are in symbiotic association with certain green plants also carry out nitrogen fixation. No animals are capable of either nitrogen fixation or nitrate assimilation, so they are totally dependent on plants and microorganisms for the synthesis of organic nitrogenous compounds, such as amino acids and proteins, to satisfy their requirements for this essential element.

Animals release excess nitrogen in a reduced form either as Nh^4+, or as organic nitrogenous compounds such as urea. The release of nitrogen occurs both during and as a consequence of microbial decomposition following death. Various bacteria return the reduced forms of nitrogen back to the environment by oxidizing then. The oxidation of NH_4^+ to NO_3^- by nitrifying bacteria. No nitrogen also returns to the atmosphere as nitrogen as a result of the metabolic activity of identifying bacteria. These bacteria are capable of using No_3^- and similar oxidized inorganic forms of nitrogen as electron acceptor in place of oxygen in energy pathways. The No_3^- is reduced ultimately to dinitrogen (N_2). These bacteria thus deplete the levels of combined nitrogen, that is, Nitrogen joined with other elements in Chemical compounds. Combined nitrogen is important as natural fertilizer.

Impact of Human Activities on Nitrogen cycle:

Activities of human beings alter nitrogen cycle in the following ways:

1) Adding of large amount of NO into the atmosphere by burning any fuel at high temperature. In atmosphere NO can be converted to NO_2 gas and HNO_3 which returns to the earth's surface as damaging acid rains.

2) The human activity adds N_2O to atmosphere through the action of anaerobic bacteria on livestock wastes and commercial inorganic fertilisers applied to soil. This gas con warm the atmosphere and deplete ozone in the stratosphere,

3) We release large amounts of nitrogen stored in soils and plants as gaseous compounds into the troposphere through destruction of forests, grasslands and wetlands.

4) No_3^- in inorganic fertilisers can leach through the soil and contaminate ground water, which is harmful to drink, especially infant and children.

5) We impair aquatic ecosystems by adding excess nitrates in agricultural runoff and discharges from municipal sewage systems.

6) We remove nitrogen from topsoil while harvesting nitrogen -rich crops, irrigate crops, and burn on clear grasslands and forests before planting crops.

Components of the Nitrogen Cycle:

Components	*oxidation* Number
Nitrate ion No_3^-	+5
Nitrite Ion No_2^-	+3
Hyponitrite Ion $N_20_2^{2-}$	+1
Nitrogen gas N_2	0
Hydroxyl amine NH_2OH	-1
Ammonia Nh_3	-3

Nitrate Assimilation:

Nitrate assimilation occurs in two steps:

(I) The two electron reduction of nitrate to nitrite, catalyzed by nitrate reductase, followed by the six - electron reduction of nitrite to ammonidim, catalyzed by nitrite reductase.

$$NO_3^- + 2H^+ + ze^- \rightarrow No^{2-} + H_2O$$

$$No^{2-} + 8H^+ + 6e^- \rightarrow NH_4 + 2H_2O$$

Nitrate assimilation is the predominant means by which green plants, algae, and microorganisms acquire nitrogen. The pathway of nitrate assimilation accounts for more than 99% of the inorganic nitrogen (nitrate of N_2) assimilated into organisms.

Nitrogen Fixation:

Nonbiological Nitrogen Fixation:

The distinguishing feature of this process a separation of the two atoms of Nitrogen. Nitrogen (N_2) is an extremely stable molecule. An indication of the difficult nature of this reaction is seen in the conditions for the fixation of nitrogen in the Haber process, developed in Germany during World War I. The Haber process involves the reaction of Nitrogen (N_2) and Hydrogen (H_2) at extreme temperatures and pressures to form NH_3 (Ammonia). The Haber process is used today for the fixation of Nitrogen by the chemical industries in the production of chemical fertilisers.

$$N_2 + 3H_2 \xrightarrow[200\ atm.]{450^0C} 2NH_3$$

$\Delta G^o = -8$ Kcal/mole N_2

Biological Nitrogen Fixation:

Biological fixation of nitrogen is accomplished either by nonsymbiotic

microorganisms that can live independently or certain bacteria living in Symbiosis with higher plants. The former group includes aerobic organisms of the soil (e.g. Azotobacter), soil anaerobes (e.g., Clostridium sp.), Photosynthetic bacteria (e.g. Rhodospirillum rub rum), and cyan bacteria (e.g. Anabaena sp.). The symbiotic system consists of bacteria (**Rhizobia**) living in symbiosis with members of the Leguminoseae such as clover, alfalfa, and soy beans. An essential feature of symbiotic fixation is the d*evelop*ment of nodular tissue that forms on the root of legumes after injection by a strain of Rhizobia specific for the given legume. The legume alone is unable to fix nitrogen; free living Rhizobia bacteria can fix nitrogen (N2) only when grown with a limiting supply of organic nitrogen & oxygen. In symbiosis, however, the Rhizobia organisms and the legume interact in a remarkable relationship to attain the formation of organic nitrogen from nitrogen gas. Biological Nitrogen (N_2) reduction is catalyzed by the enzyme nitrogenise. The nitrogenise is the molybdenum (Mo)-dependent enzyme, such as that found in Azotobacter vinelandii. The stoichiometry of the overall reaction is as follows:

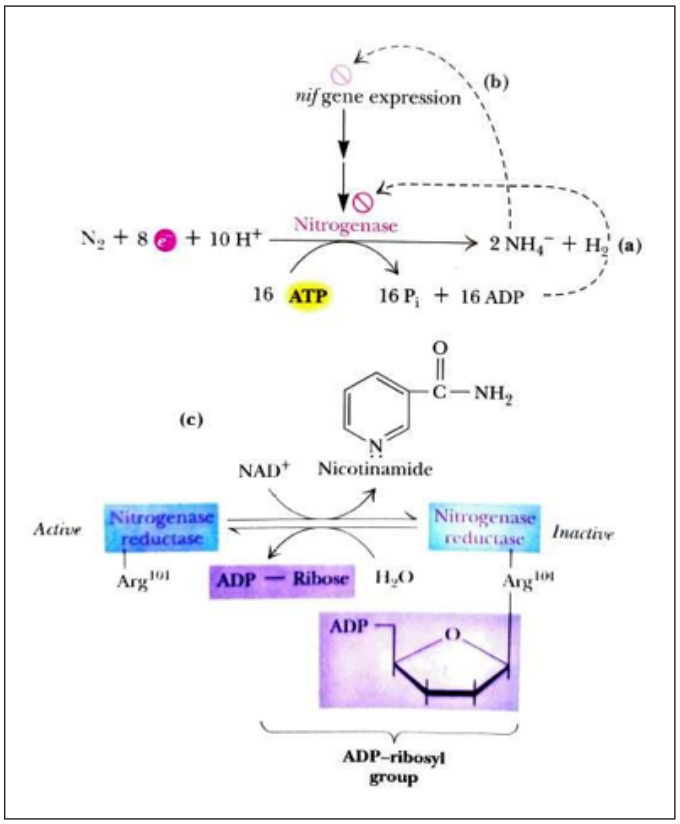
$$N_2+8H^++16MgATP+8e^- \longrightarrow 2NH_3+H_2+16MgADP+ 16PE$$

Regulation of Nitrogen Fixation:

There are two regulatory controls are pare

(i) ADP inhibits or the activity of nitrogenise; thus as the ATP/ADP ratio drops, nitrogen fixation is blocked.

(ii) NH_4^+ represses the expression of the nig genes the genes that encode the proteins of the nitrogen fixing system. Some 20 nif genes, have been identified with the nitrogen fixation process, Repression of naïf gene expression by ammonium, the primary product of nitrogen fixation is an efficient and effective way of shutting down Nitrogen (N_2) fixation when its end product is not needed. In addition, in some systems, covalent model of nitrogenise reductase leads to its inactivation. Inactivation occurs when Arg^{101} of nitrogenise reductase receives an ADP-ribose group donated by NAD^+



DISCUSSION AND RECOMMENDATIONS:

Nitrogen is the main component of proteins and nucleic acids. Animals receive nitrogen always as amino acids and plants get it as soluble nitrogen salts in the soil. Plants synthesize proteins and amino acids by combining glucose and other carbohydrates with nitrogen. Animals use the proteins of the plants to make up protoplasm. Nitrogen cycle begins with the death of animals and plant material and goes thorough five steps".

(i) When the animals die and the animal - wastes, such as of access and urine fell on the soil or when the plant materials fall to the ground, the nitrogen compounds in all of them pass into the soil.

(ii) The decomposers, specially certain Saprophytic bacteria in the soil, ser out to convert these useless compounds into compounds that the green plants can use for synthesizing proteins. The first product of the bacterial break-down of organic wastes is ammonia (Nh_3).

(iii) Ammonia as such cannot be used by the plants therefore, at the end of certain chemical reactions ammonia is converted into soluble ammonium carbonate. Ammonium carbonate ionizes to produce NH_4 (ammonium) ions, some green plants can use these ions immediately.

(iv) The nitrifying bacteria in the soil such as Nitrosamines and Micrococcus oxidize ammonium ions into water and Nitrous acid.

$$(NH4)_2CO_2+30_2 \longrightarrow 2\,HNO_2+CO_2+3H_20+\text{Energy}$$

(Nitrous acid)

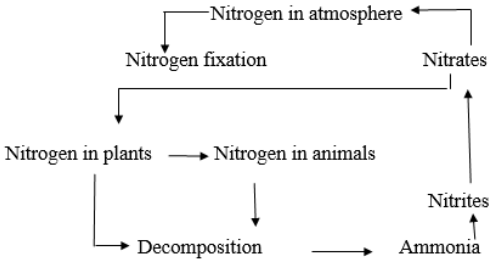
Nitrous acid immediately combines with for example; calcium or magnesium salts to form a nitrite. Another nitrifying bacterium, Nitrobacteria oxidizes nitrites to nitrates –

$$2\,Ca(NO_2)_2+0_2 \longrightarrow 2ca(NO_3)_2+\text{Energy}$$

In all cases the energy released is used for the synthesis of organic compounds. These bacteria do not exist in isolation but from part of a natural system in which nitrogen compounds are converted from one form to another step by step.

(v) Nitrates are quickly soluble and taken by the roots of the plants for they are waste products for the bacteria.

The nitrogen fixing algae and bacteria live in the soil and in the root nodules of leguminous plants in Symbiotic association. Nitrogen fixing bacteria utilise atmospheric nitrogen in their own metabolism and convert it into nitrates. The denitrifying bacteria in the soil which degrade some into nitrites, nitrites into ammonia and ammonia into nitrogen, then nitrogen return to the atmosphere.



Nitrogen cycle

In order to maintain a proper balance between the environment and human survival, it becomes imperative to incorporate concepts of immediate concern that have direct implications not only to theory but practical work and their subsequent application for environmental protection and human survival. This is also significant with the viewpoint to bring out social awareness towards the protection of environment, human survival and then to maintain the ecological balance. Based on the finding obtained from the present study the following recommendations can be advanced since the incorporation of units of atmosphere and its resources plays a significant role in bringing about.

(i) Awareness for maintaining a proper balance among man, plants, animals and nitrogen so that the proper balance between the same may not be disturbed.

(ii) The study of such concepts as nitrogen cycle should be specifically introduced in the course of study related to the biological sciences at various levels.

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